Determination of Strain-Optic effect on Silicon Nitride/Silicon Oxide Waveguides

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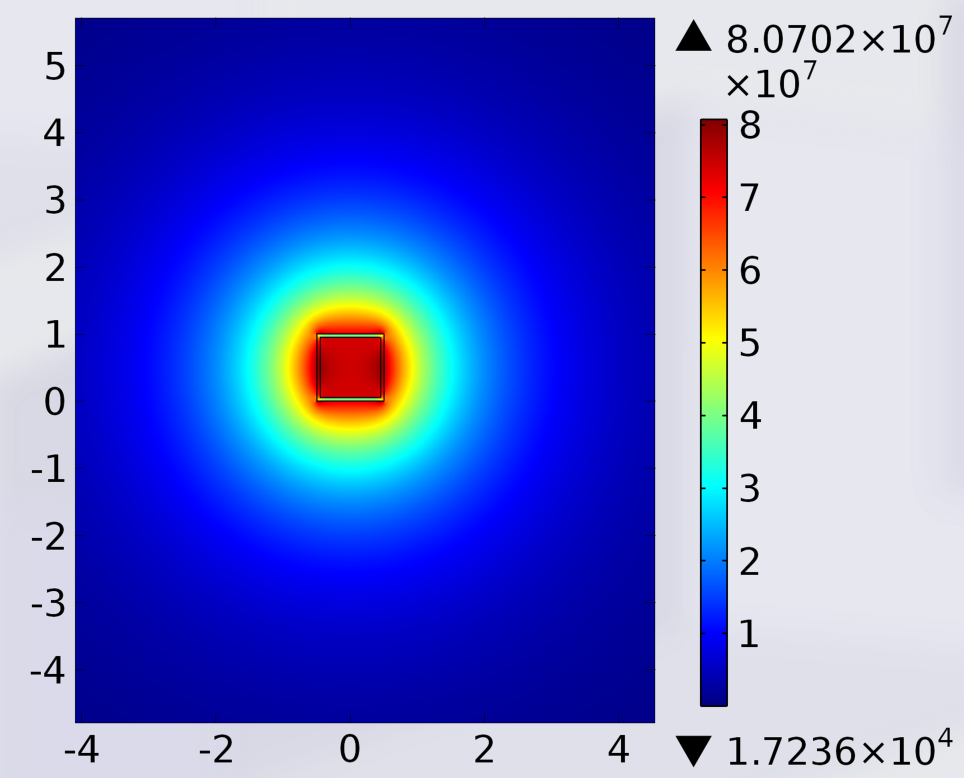
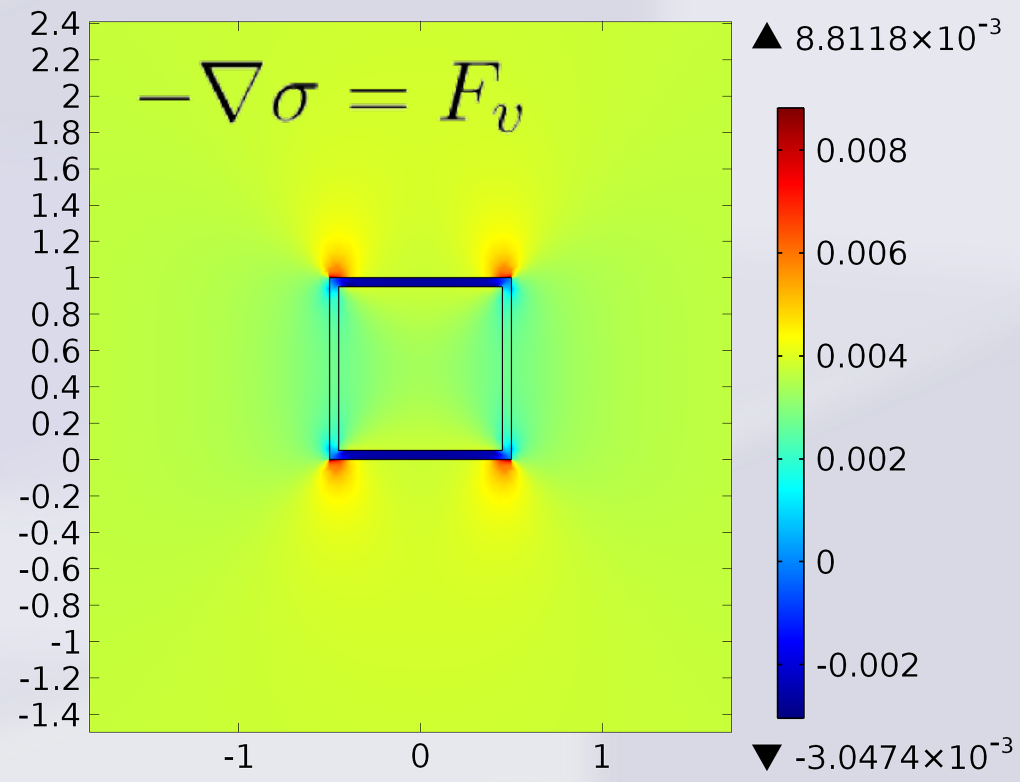
We investigate the strain-optic effect on Silicon Nitride waveguides. The aim is to use modeling and experiments to optimize this effect for the implementation of acousto-optic integrated devices. The deformation generated through a metallic tip will help to characterize the degree of deformation that is required from PZT.

Theory

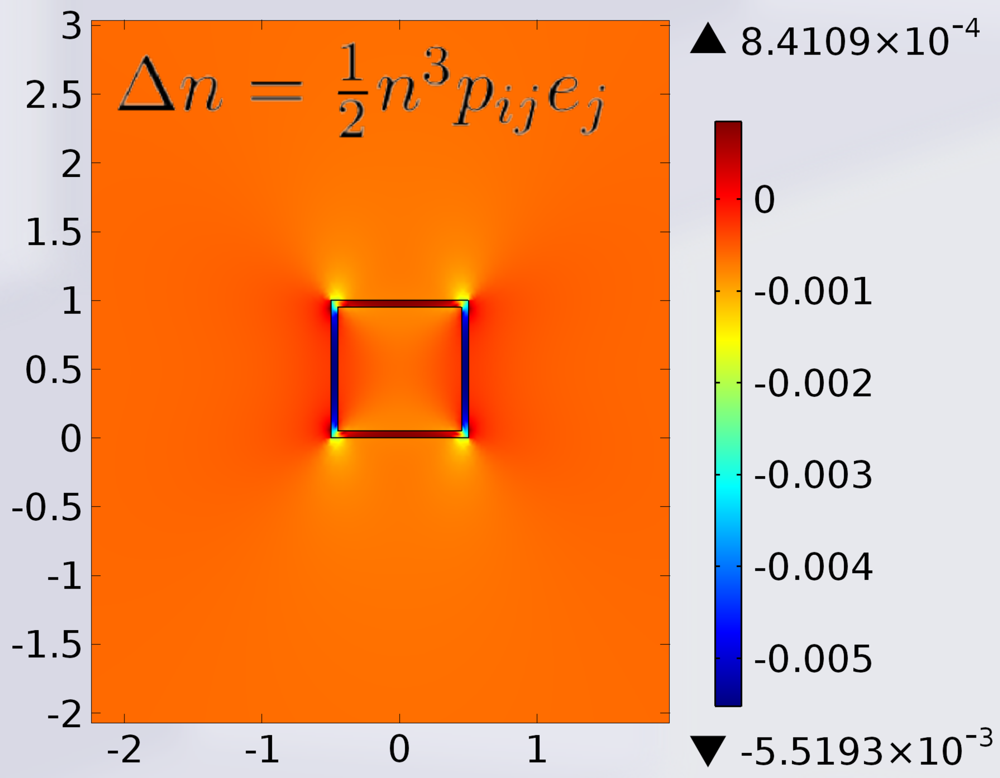
Box waveguide 1x1µm with 50nm silicon nitride thickness



Intensity profile of fist TE mode. n_{eff} 1.449.

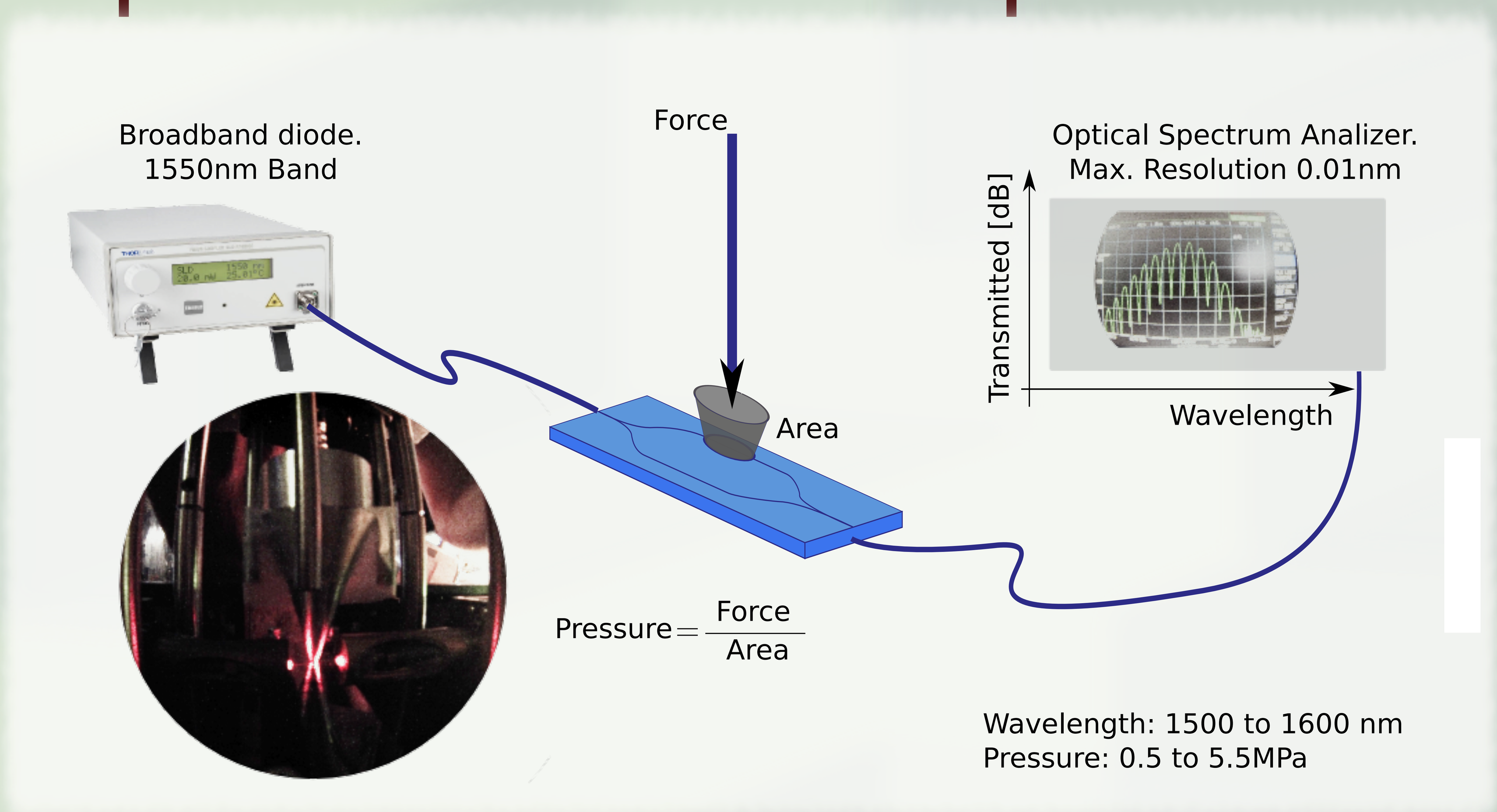


Mechanical Strain Profile in X direction.



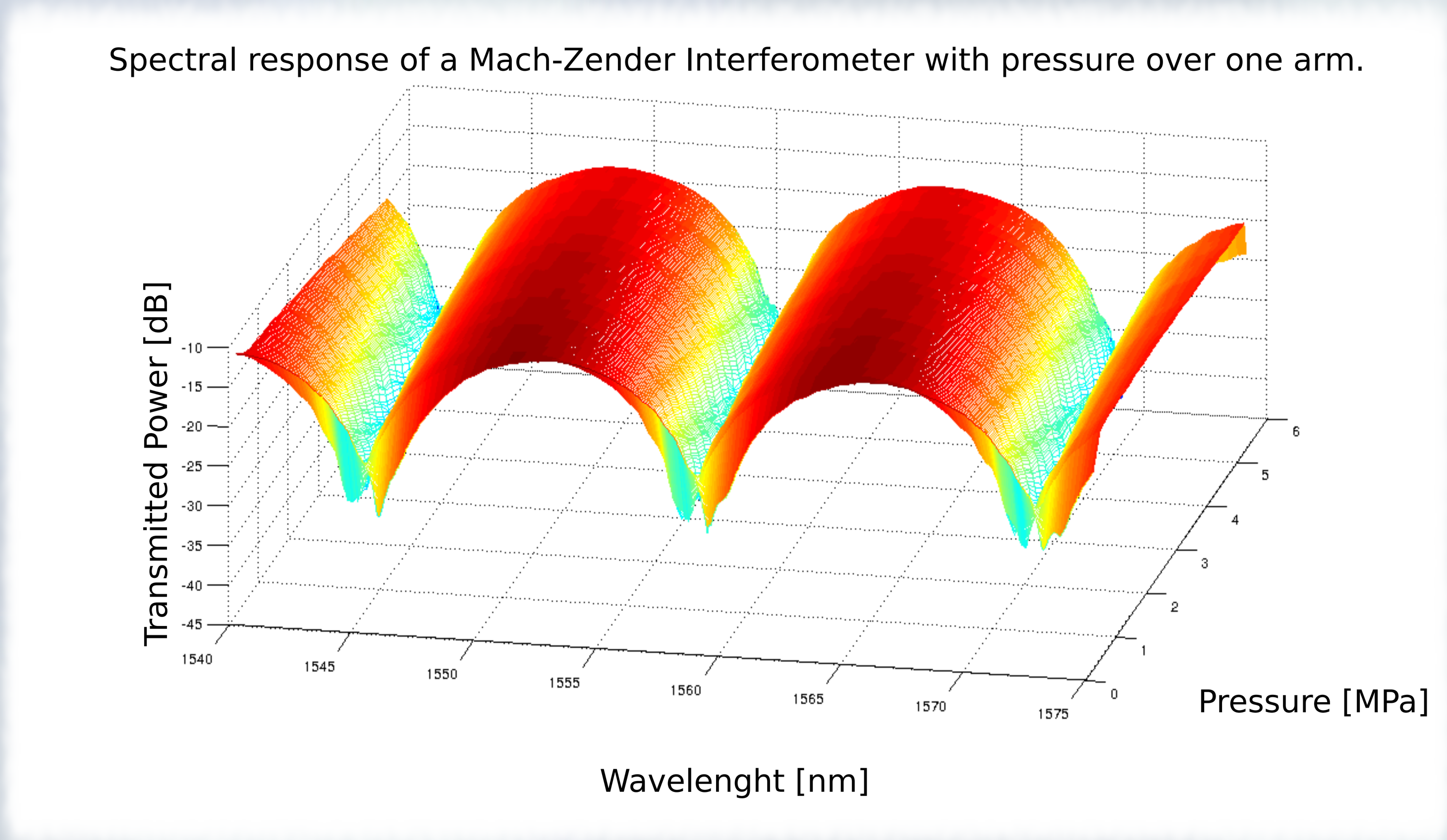
Puntual index change for TE due to strain in X and Y

Experimental Setup



Experimental Setup. Picture of the system used to apply pressure. 2mm diameter circular tip.

Results



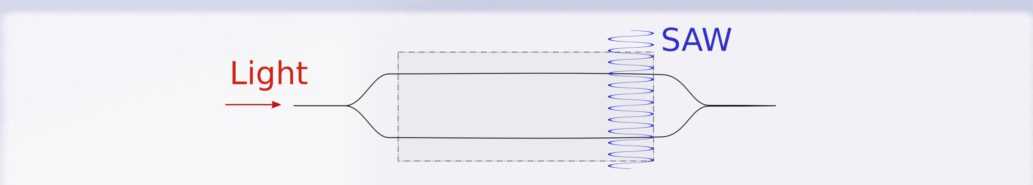
Measured amplitude per frequency response under different pressures are applied to the waveguide.

Applications

Surfaces Acoustic Waves (SAW) devices have been widely used as optic modulators on crystaline surfaces [1,2].

Calculations have shown that it is possible to use strain-optic effects on amorphouse glass waveguides systems such as TripleX (not shown here).

Numerical calculations of the characteristics of SAW created by PZT show promising results leading to design of this devices:



Surfaces Acoustic Wave device with perpendicular interaction. The SAW is phased 180° between arms to provide tensile and compressive strain enhancing the effect.

Conclusions

This experiment lead us to an approximate value of the effective strain-optic p_{12} of the waveguide to be 0.5 0.1. The components of this strain-optic tensor are not yet fully understood. A more accurate and controlled experimental setup will allow more exact calculations of the complete strain-optic tensor. In addition,different waveguide geometries will take us to a complete characterization not only of the strain-optic tensor of the waveguide but possibly of the thin film silicon nitride.

References

[1] I. Chang, Acoustooptic devices and applications, *IEEE Transactions on Sonics Ultrasonics* 23, 2-22 (1976).

[2] M.M de Lima & P.V. Santos, Modulation of Photonic Structures by Surfaces Acoustiv waves. *Report on Progress in Physics* 68, 1639-1707 (2005).

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